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(54) Echo sounding system with two transmission frequencies

(57) An echo sounding system comprises a transmitter including transducers 2, 3 for transmitting pulsed sound energy at slightly different high frequencies and a receiver including a transducer 11 for receiving a low difference frequency echo signal, a transducer 12 for receiving one of the high frequency echo signals, an indicator 18 and signal generators 15, 16 for imposing distinguishable characteristics on the two indicated echo signals.

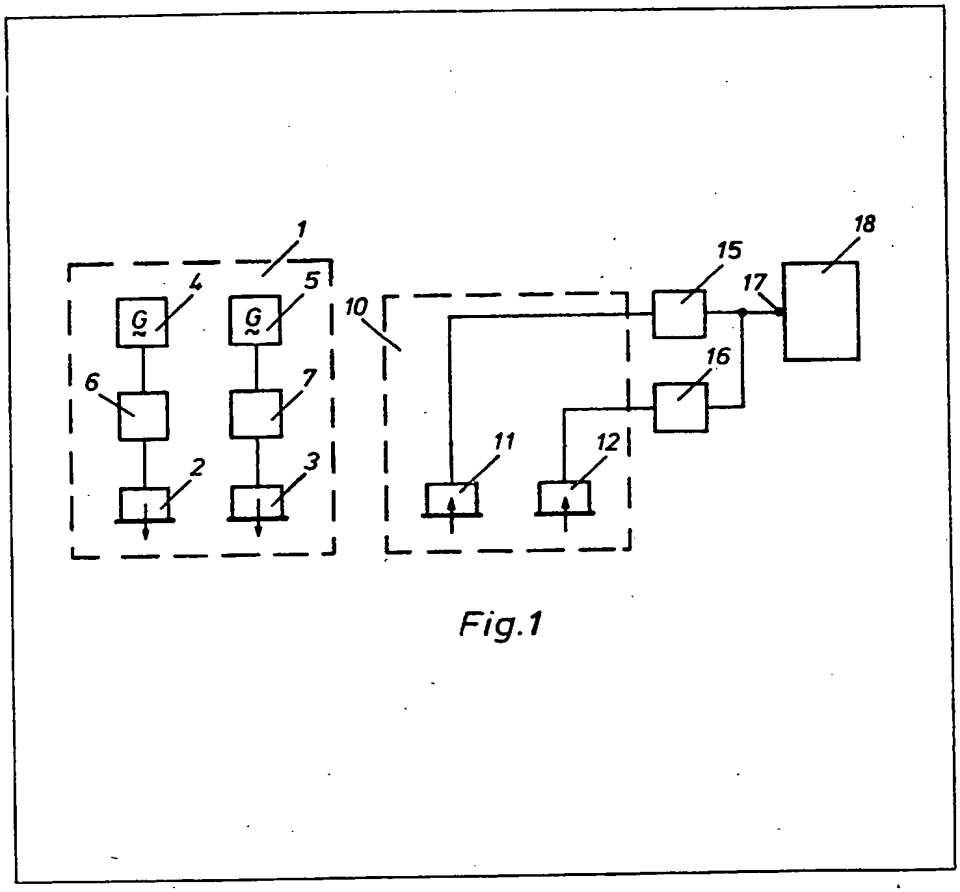

Fig.1

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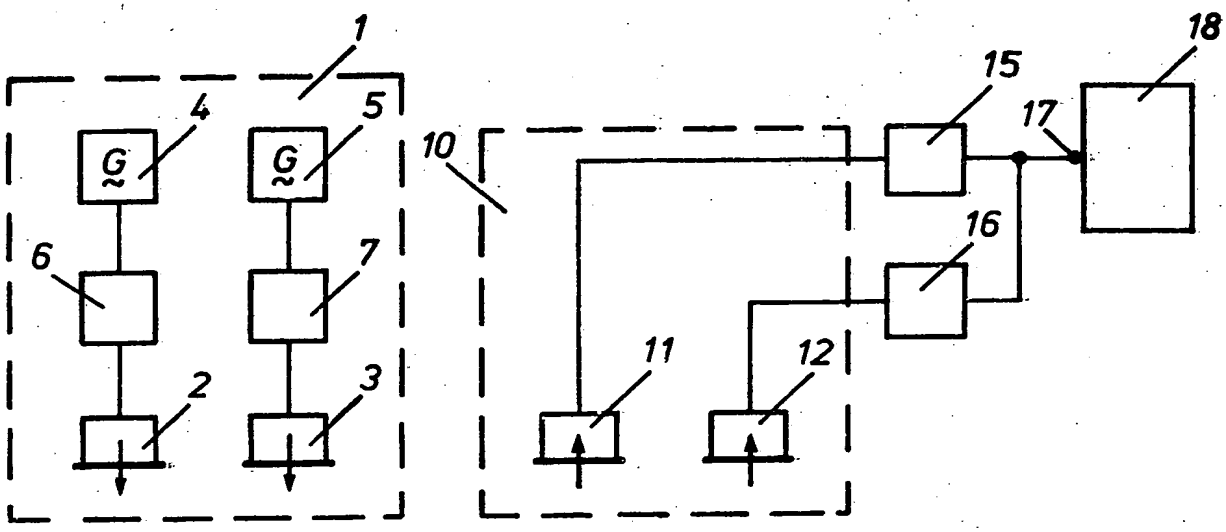

Fig.1

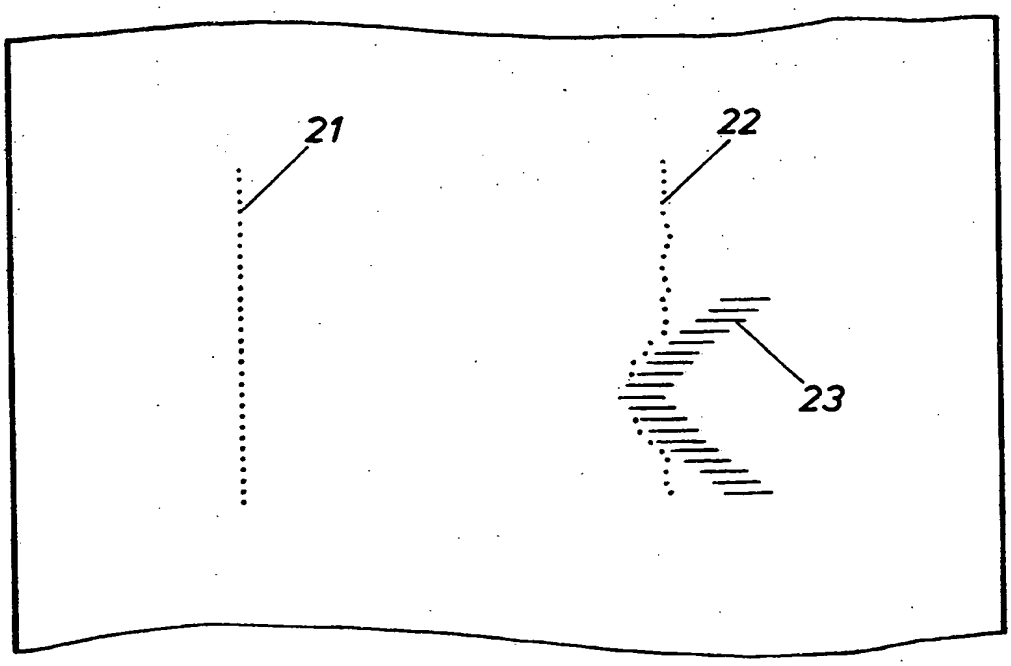

Fig.2

SPECIFICATION

Echo sounding system with two transmission frequencies

The invention relates to an echo sounding system, comprising a transmitter including two transducers for simultaneously transmitting pulsed sound energy at slightly different high frequencies, the propagation in water of which generates a low difference frequency, and a receiver including a low frequency transducer for receiving the difference frequency echo signal and an indicator for portraying the echo signals in terms of travel time and having a signal input connected to the low frequency receiving transducer.

It is known to use echo sounding systems operating at multiple transmission frequencies for differentiating between layers of the sea bottom. Sure differentiation between hard and soft layers of the bottom of a stretch of water is necessary for vessels particularly in areas in which, as is known with supertankers, there is very little water under the keel while travelling over a muddy bottom which may be contacted. In such areas continuous observation of the bottom is necessary to determine whether a muddy layer of the bottom conceals objects which could endanger the vessel.

In a system described in German Specification 1017054 differentiation between layers of the bottom is achieved by transmitting pulsed sound energy of two frequencies. Sound energy of the higher frequency is reflected by the upper layer of the bottom and does not penetrate so that it provides echo signals indicative of the position of this upper layer.

Sound energy of the lower frequency penetrates the bottom and provides echo signals from deeper levels of the bottom.

This mode of operation involves difficulties in portrayal of the received echo signals on a common indicator. These difficulties arise because during echo sounding the directional characteristic of the high frequency sound energy is very narrow while it is very wide for low frequencies. A wide directional characteristic results in the known effect of an apparent prolongation of the bottom echo, because sound energy is reflected not only from parts situated vertically below the apparatus but also from adjoining parts of the bottom, but staggered in time in relation to the echo signal from the vertical direction. This prolonged echo signal can mask echo signals from deeper layers of the bottom which appear during the duration of the bottom echo.

A further difficulty in portrayal of received echo signals of different frequency on a common indicator arises in connection with portrayal of echo signals from slopes, since low frequency echo signals can sometimes arrive sooner from a slope than from the bottom while echo signals of higher frequency always give positionally correct portrayal. This results in overlapping in the portrayal, as described for example in Volume 1 of "Beiträge zur Schallortung" on page 51 and in Figure 19 behind page 51. This volume appears in the series "Sonderbucherreihe der Funkortung" of the commission for radiolocation and contains the papers of a committee for sound location given at a conference in Bremen on 19th October 1953. The publisher is State Secretary Professor Dipl.Ing.L.Brandt.

It is therefore the object of the present invention to provide an echo sounding system which results in positionally correct portrayal of echo signals of higher and lower frequency.

In achieving this object the invention proceeds from the arrangement described in DE—PS 2204028, which results, by use of two slightly different high transmission frequencies in water, in production of a low difference frequency.

This object is achieved in accordance with the invention in that the receiver includes a second high frequency transducer for receiving echo signals of one at least of the two transmission frequencies which is also connected to the signal input of the indicator.

This system renders it possible to obtain during each sounding period echo signals from the different layers of the bottom. The received high and low frequency echo signals are indicated during each sounding period in accordance with their transmit time on a common trace. The resulting echogram gives positionally correct portrayal of the layers of the bottom as depth lines.

With a hard and rocky bottom only one depth line appears, as there is only a single reflector and all received echo signals have the same transit time.

Discrimination between the high and low frequency echo signals is unnecessary, the directional characteristics of the sound pulses of the difference frequency and of the two higher transmission frequencies do not differ significantly in aperture angle so that overlapping and masking in the portrayal are avoided.

This possibility of indicating the echo signals of different frequency during each sounding period on a common trace is achieved simply and with certainty by the use in accordance with the invention of the two high transmission frequencies and the low difference frequency. Thus the use of an additional second echo sounding unit with a high transmission frequency has the disadvantage of formation of additional difference frequencies between the two transmission frequencies of the one and the transmission frequency of the other echo sounding unit, the directional characteristics of which are of different width, which can falsify the portrayed echo signals. Such an arrangement cannot achieve the object of the present invention. An arrangement including two echo sounding units cannot therefore be used without special mutual control of the units.

A rapid sounding sequence, which is always desirable, can only be achieved with an echo sounding system according to the invention.

Advantageously one of the two transmitting transducers can also be used as a high frequency

receiving tranducer. To this end this transducer is connected to the transmitter and the receiver by a send-receive switch. This provides an especially simple and inexpensive echo sounding system as no individual second high frequency receiving transducer is required and the cost of a send-receive switch, such for example as that described in German Specification 954135, is very small.

For intelligible portrayal of the layers of the bottom it is advantageous to impose distinguishable characteristics on the echo signals received by the two receiving transducers. Thus in accordance with an additional feature of the present invention the difference frequency echo signals may be portrayed at greater intensity to give immediate indication of hard bottom layers. Such an echogram indicates whether, and to what extent, a hard layer reaches or penetrates the upper muddy layer. The portrayal shows whether a hard layer penetrating the upper layer is a rocky peak, or an object of limited size such as a buoy or a pipe.

The difference in intensity can be indicated by differential blackening of the chart of an echograph.

For portrayal on a cathode ray tube characterisation of the echo signals can be effected, according to another feature of the invention, by pulses of different length as a cathode ray tube cannot portray large differences in intensity.

It is also possible to combine these two modes of characterisation or to portray the echo signals in different colours on a television tube, which is advisable in cases of an echo sounding system which already uses a television tube as the indicator.

The main advantage secured by the invention is that in each individual sounding period information is given as to the layers present in the sea bottom.

An embodiment of the invention will now be described with reference to the drawings, in which: —

Fig. 1 is a block circuit diagram of a system according to the invention, and

Fig. 2 shows an echogram obtained with this system.

As shown in Fig. 1, the echo sounding system includes a transmitter 1 which contains two transducers 2, 3 for transmitting pulsed sound energy at slightly different high frequencies. The transmission frequencies are formed in two oscillators 4, 5 which are followed by pulse senders 6, 7 which control the transducers 2, 3.

On transmission of the sound energy, pulses of the two transmission frequencies are propagated in water and also a sound pulse having a frequency corresponding to the difference between the two high transmission frequencies. A receiver 10 includes a low frequency transducer 11 for receiving the difference frequency echo signal. The receiver 10 contains a high frequency transducer 12 for receiving at least one of the two transmission frequencies.

The two receiving transducers 11, 12 are connected through signal generators 15, 16 to the signal input 17 of an indicator 18. The echo signals are portrayed on the indicator 18. The preceding signal generators 15, 16 impose differentiating characteristics on the echo signals from the two receiving transducers 11, 12.

Part of an echogram received with the system according to the invention is shown in Fig. 2. A null line 21 indicates in known manner the time of release of the transmitted pulses. Received echo signals of the low difference frequency and the high transmission frequency are indicated in terms of their transit time during each sounding period on a common trace on the echogram. They show the depth of the water and the position of layers in the bottom. The echo signals of high transmission frequency, the sound energy of which does not penetrate the bottom, are reflected at the upper layer of the bottom and are characterised to give a dotted portrayal.

The differential frequency echo signals, the sound energy of which can penetrate deeply into the bottom, are reflected by hard layers in the bottom. They are characterised by a pulse of prescribed duration and are portrayed as lines 23.

This characterisation yields a distinctive portrayal of the configuration of the bottom on the echogram. The difference frequency echo signal shows presence in the bottom of an object of limited size which projects somewhat from the upper layer and that there is no rocky peak extending upwardly from a lower layer.

CLAIMS

1. An echo sounding system, comprising a transmitter including two transducers for simultaneously transmitting pulsed sound energy at slightly different high frequencies, the propagation in water of which generates a low difference frequency, and a receiver including a low frequency transducer for receiving the difference frequency echo signal and an indicator for portraying the echo signals in terms of travel time and having a signal input connected to the low frequency receiving transducer, characterised in that the receiver includes a second high frequency transducer for receiving echo signals of one at least of the two transmission frequencies which is also connected to the signal input of the indicator.

2. An echo sounding system according to claim 1, characterised in that one of the transmitting transducers is connected to the transmitter by a send-receive switch and, after transmission, is connected to the receiver to serve as the high frequency receiving transducer.

3. An echo sounding system according to claim 1, characterised in that signal generators for differential characterisation of the two receiving transducers are connected to the signal input of the indicator.

4. An echo sounding system according to claim 3, characterised in that the signal generators impart different intensities to the echo signals.

5. An echo sounding system according to claim 3, characterised in that the signal generators are pulse generators for producing pulses of adjustable duration.

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